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A N

E S S A Y

O N



G A N G L I O N S O F T H E

N E R V E S.

By JAMES JOHNSTONE, M. D.

In experimental Philosophy Propositions collected from the Phœnomena by Induction, are to be deemed, notwithstanding contrary Hypotheses, either accurately or very nearly true, till other Phœnomena occur, by which they may be rendered either more accurate or liable to Exceptions. Newton's 4th Rule of Philos. Pr. Math.

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An Historical Dissertation concerning the Epidemical Fever which prevailed at *Kidderminster*,
in 1756.

By JAMES JOHNSTONE, M. D.

T O

THE RIGHT HONOURABLE

G E O R G E

L O R D *L Y T T E L T O N,*

T H I S E S S A Y,

I N T E S T I M O N Y

O F

T H E M O S T S I N C E R E E S T E E M

A N D V E N E R A T I O N,

I S

M O S T R E S P E C T F U L L Y I N S C R I B E D,

B Y

T H E A U T H O R.

Advertisement.

THE first sketches of this Essay were several years since put into the hands of Dr. LYTTELTON, the late worthy Bishop of CARLISLE, and President of the Antiquarian Society; who, with all the qualities that endeared the Friend and adorned the Gentleman, had that affection to learning and science, which seems congenial to his family.

HIS Lordship presented to the Royal Society that Paper and a Supplement to it; and they are published in the 54th and 57th volumes of the *Philosophical Transactions*. If they appear in this republication with any new advantages, they are owing to the friendly and candid remarks of very distinguished judges of this subject; which,

ADVERTISEMENT.

which, however, appearing insufficient to overturn this theory, led me to make such additions and to try such experiments, as seem to clear up the objections made to it, and illustrate and enforce the principal doctrine with so much preponderance of argument and evidence, as will probably entitle it hereafter to consideration in the physiology of the nerves, and involuntary motions of animals; and may encourage students in anatomy to supply my deficiencies, and become improvers of this subject, and in the nervous system at large; which is every where an open and inviting field for inventive Genius.

No one can be more sensible than I am, that with very inadequate qualifications, I have undertaken a most difficult task. The utmost I flatter myself to have done, is to have stum-

A D V E R T I S E M E N T.

stumbled upon a Path which may be beaten by others to the instruction and advantage of mankind. In this hope I submit this Essay to the Publick, and I believe take a farewell of this subject, in the persuasion and words of SENECA, " multum adhuc
" restat operis, multumque restabit;
" nec ulli nato post mille secula præ-
" cludetur occasio aliquid adhuc ad-
" jiciendi."

E R R A T A.

- Page 27 line 5 Volition—read—Volition;
- 73 line 4 are—read—seem.
- 85 note (n) this—read—This is a truth,
- 88 as He is—read—HE is.
- 91 line 14 wisdom—read—wifdom,

T H E
C O N T E N T S.

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	An



An E S S A Y

ON THE
USE OF THE
GANGLIONS of the NERVES.

S E C T I O N I.

The use of the Ganglions of the nerves not hitherto ascertained: Introductory Propositions concerning the nerves in general.

THE Ganglions of the intercostal, or, great Sympathetic Nerves, described by FALLOPIUS (*a*), are oblong, and, very hard knotty bodies; the uses of which, have not been satisfactorily

(*a*) The word Ganglion, is a Greek root, found in CELSUS, and GALEN, and preserved in modern Books of Surgery; it was at first used as the name of certain hard Tumors, seated on the ligaments or sinews. The resemblance of the ganglions of the nerves, real or fancied, to these morbid tumors, was probably, the

ESSAY ON THE USE OF

SECT. factorily ascertained by any one. From
 I. some vague resemblance, which Anato-
 mists fancied they found in these
 knots, to those in the roots of some
 Plants and branches of Trees; it was
 supposed, their use consisted in giving
 some additional *firmness* to the nerves:
 but this has not often been repeated, by
 Anatomical writers after WILLIS and
 VIEUSSENS. Few Anatomists, have in-
 deed

the occasion, of their being called, by FALLOPIUS, indiscriminately Ganglia, as well as, corpora olivaria & Plexus. These Terms, and those of consociation, and, association, of nerves, were used by succeeding Anatomists, as synonymous, till about the beginning of this Century: That, the knots, peculiar to certain nerves, I think, for the most part, are, now only, called Ganglia. The other unions of the nerves, without intumescence, or hardness, are called Plexus; and, in this distinct sense, we shall use these words, throughout this Essay:

"Corpora olivaria aliquando concrescunt, incerto tamen nu-
 "mero, quæ nulla alia *substantia* quam *nervæ* & quasi in *callum*
 "concrecente constant.—Cum ego primus talem nervorum co-
 "pulam observarim, primus quoque nomine imposito plexum appell-
 "labo: a quo plexū plures nervi ad cordis basim feruntur." FAL-
 LOP. Obs. Anat. edit. cum oper. VESAL. p. 737. The ingenious
 Dr. MARTIN concurs with VESALIUS, in diminishing the
 pretensions of FALLOPIUS as the first discoverer of the ganglions
 of the nerves, and in giving that honour to GALEN. See Com-
 ment. in EUST. Tab. p. 208.

deed examined this Subject, with that SECT. attention and accuracy, with which it is discussed, by the learned J. M. LAN-
CISI. He imagined the Ganglions, to be muscles *sui generis*, and, like other muscles, capable of contractions; by which he thought, the nervous spirits were accelerated and impelled with such additional forces, as are by him, supposed necessary to the production of motions in muscles subject to the Will: And, in order to give an Idea of the structure of all other Ganglia, he particularly describes, and delineates, that of the first cervical Ganglion. (b)

THIS Theory has the misfortune to be erroneous in its foundation; for that most accurate and skilfull Inquirer into subjects of this nature, the illustrious Baron HALLER, and other celebrated Anatomists, have not been able to

(b) See LANCISI's Dissertation published in the *Adversaria Anatomica* of MORGAGNI.

SECT. discover this muscular apparatus in the
I. *first cervical Ganglion (c)* or in any other
~~—~~ *Ganglion.* The coverings and substance
of Ganglia, with the appearance, have
all the firmness of ligamentous sub-
stance, but are incapable of that ex-
tention and contraction which *muscular*
fibre, *ever elastic*, always allow of.

GANGLIONS besides, instead of being instruments subservient to the Will, are almost peculiar to nerves, distributed to parts, the motions of which are totally involuntary. And our Author must indeed have been greatly misled by his Hypothesis not to observe this striking circumstance. The Theory, which prevailed in his time and country, of the action of the Dura mater upon the Brain, now exploded, might lead this great Man more entirely to believe an analogous muscular power in Ganglions.

But

But the Brain needs no muscular force SECT.
to impress motion upon the animal I.
spirits; *the power presiding there, is of ~~one~~*
a different kind: Nor, granting Gang-
lions to be, as is ingeniously conjectured
by LANCISI and WINSLOW, subsidiary
Brains, or analogous to the Brain in
their uses, will they need any such mus-
cular apparatus and force. A Power,
in fine, absurd no less than imaginary,
as it supposes the force of muscles of
the greatest exertion and effect, to be
derived from those of least bulk and
strength: (which must, cæteris pari-
bus, be in proportion to the quantity of
muscular fibres), and would be a single
instance of a mechanical force producing
another infinitely greater than itself.

THE accurate WINSLOW, reckons
the Ganglions, especially those of the
spinal nerves, to be so many dispersed
origins of the great sympathetic nerves;
but

SECT. but goes no farther in pointing out their
I. use. The late Professor MONRO, in
— his excellent Treatise upon the nerves,
and the illustrious Baron HALLER, in
his great Work, in which he gives a
complete view of every thing that re-
lates to the physiology of the Human
Body, with most other Anatomists,
esteem the uses of the Ganglions ab-
solutely unknown.

BEFORE I proceed to examine into
the uses of Ganglia, it will be proper
to premise, as first Principles, the fol-
lowing Propositions concerning the
nervous system, which are demonstra-
ted by Anatomists and Physiologists.

i. THE Brain consists of a glandular
substance of a cineritious color, and a-
bounding with blood vessels, called its
cortical substance : The medullary part
of the Brain, arises from the cineritious,
and

and the nerves from the medullary SECT. substance; of which they are prolongations. I.

2. EVERY Nerve is, properly speaking, a bundle of smaller nerves, or cylindrical threads; all of which run parallel to each other, without confusion (except perhaps in Ganglions) from the Brain to their terminations; every funicle of which a nerve consists, has its membranous coat, continued from the Pia mater.

3. THE funicles (2) which to the unassisted eye seem single, and to compose a nerve, with the help of a Microscope, are found made up of innumerable smaller filaments.

4. THESE nervous filaments or threads, derived from the medullary part of the Brain; convey impressions or sensations to

SECT. to the Soul, or sentient Principle seated
I. there.

5. Undoubted Experiments demonstrate that the Power of voluntary motion is derived from the Brain, by the nerves, to the muscles of the part moved. By experiments we endeavour to imitate or illustrate this; thus, if the Brain, or any nerve issuing from it, be stimulated by any irritating cause, the parts whose nerves are irritated, whether in the Brain, or lower down, will always be convulsed. And ligatures upon nerves, with no less certainty intercept the efficacy of this irritation above them, than they render the parts paralytic or immovable by the Will.

6. BUT this power or cause which is conveyed by nerves, and puts muscles in action, is not instantly lost in nerves,
when

when their communication with the SECT.
Brain is interrupted by cutting the nerve I.
asunder, or tying a tight ligature upon  it. For if the nerve be irritated below,
or betwixt the section or the ligature,
and the muscle it goes to ; the muscle
is convulsed as effectually, as if the
communication with the Brain had not
been cut off. Thus, after the Head
is cut off, irritations of the spinal mar-
row convulse the trunk of the Body
and limbs entirely : In like manner irri-
tations of particular nerves, the *Phrenic*
for example, after the destruction of
the spinal marrow, throw the Dia-
phragm into convulsive contractions :
Thus the muscles of the head, eyes,
and tongue are convulsed by probes
thrust into the brain, when the head
is separated from the body : And thus,
the Heart itself is made to contract, af-
ter it is separated from the body. So

SECT. that it is evident, that, tho' in a general view and ultimately, the nerves and muscles depend upon the brain for their fluid, or whatever is the cause of their energy, yet, that dependance is by no means so immediate, but that effects may be produced by and in nerves and muscles separated from the brain, through that remaining stock of energy, sometime before derived from it, and not so suddenly dissipated and exhausted, as some Theories would incline us to believe.

Hence also we may conclude, that it is not certain that Irritability is so entirely a distinct property of muscular fibres, as to be totally independent of the nerves; as no experiment can be contrived, in which muscular fibres can be perfectly separated from the nervous web, intermixed with, and diffused a-

mong them ; and to which the con- SECT.
traction of muscles irritated after sepa- I.
ration from the Body, may be owing —
in a great measure.

SECTION II.

Seat and genuine use of Ganglions.

SECT. I. GANGLIONS are observed
II. to be seated generally upon

↔ nervous cords, formed by the union
of several different nerves; and some-
times too before nervous cords send
off branches.

ALL of them except the ophthalmic
ganglion, (and two or three besides,
belonging to the fifth pair not constant-
ly found) either are seated upon the
great sympathetic nerves, or are, as we
shall experimentally shew hereafter, to
be considered as their origins.

2. THEY

2. THEY appear to abound with SECT. blood vessels; and it is observed by M. H. DE HALLER, that the nervous filaments lose in ganglions, their rectilineal parallel direction (No. 2. above) and seem to be intimately commixed therein (*d*).

3. THE bulk of a Ganglion constantly exceeds that of all the vessels and nerves which it receives, and of which it may seem composed (*e*). Hence we

may

(*d*) This was already observed by GLISSON, who calls the ordinary unions of the nerves *Associationes*, and those now called Ganglions, he calls *Plexus*. "Inter associationes hasce & plexus id discriminis est, quod illæ *fibras suas peculiares magis distinctas, minusq; invicem implicatas servent*; quod etiam *nodis ut plurimum careant*." GLISSON, de Anatome Hepatis.

This is confirmed by the Authority of Baron HALLER, In Ganglio involucrum ex dura cellulosa tela est, sive Vagina Rubens firma, ipsique etiam funiculi nervei interrumpuntur, ut fibrarum porro rectarum parallellum ductum, non distinguas, videanturque ii funiculi intime commisceri. HALLER Elem. Ph. T. iv. p. 203,—Prim. Lin. No. 377.

(*e*) Gangliorum moles major est quam sit aggregatum omnium vasorum ingredientium atque egredientium; quo sit, ut ad eorum productionem, necesse sit concurrere, praeter communia vasa, *peculiarē aliud corpus*, non tam ex cohærentia & complicatione præfatorum nervorum, ac sanguiferorum, *quam ex novis organicis partibus*

SECT. may reasonably conclude, that in Ganglion the different nervous filaments are very intimately mixed; that a new nervous organization, or arrangement of the medullary substance probably takes place in them, and is subservient to some important purpose in the animal Machine; a conjecture which has the sanction of a WINSLOW, and the latest as well as the earlier thoughts of the great MORGAGNI in its favour, (*f*) tho' that purpose is not pointed out by them.

In order to determine the particular use of Ganglions, (the intimate structure

tibus quas provida solersque natura, subsistentibus probeque excoctis liquidis, simul etiam elongatis varieque dispositis solidorum fibris, fingat & creat. LANCIS. de Gangl:

Certum est, ganglia constanter majora esse, & nonnunquam insignissime majora quam nervus est ex quo quodque oritur. Certum est etiam, nervos ex gangliis fere semper numerosiores prodire quam subierunt. HALLER, ib.

(*f*) See MORGAGNI Adversar Anatom. T. ii. p. 71. & ejusdem de Sedibus & Causis Morb. Epist. 12. Art. 14. Ces ganglions sont compose's d'un melange de Substance Moelleuse, & de substance cendree, arrose de plusieurs petits vaisseaux Sanguins. Traite' de la Teste. 629. WINSLOW.—See also his Exposition Anatomique, p. 462. 4to.—and following quotation;

ture of which, equally with that of SECT. the Brain, and medullary substance of II. the nerves, we are hitherto ignorant of) ~~—~~ in the animal system; let us try if something tending this way may not be suggested, by reflecting on the functions and motions of the parts supplied principally by nervous cords from below the Ganglions.

THE intercostal, more fitly called the great Sympathetick nerves, abound most with Ganglions (*g*) ; and by examining

(*g*) Ces nerfs communement appelle's Intercostaux “ Dans toute leur etendue, ils representent deux cordons, devise's & comme entrecoupe's d'espace en espace par un grand nombre de petites tumeurs ganglioformes, moyennant lesquelles ils communiquent en arriere par deux fillets collateraux fort courts, & produisent en devant toutes leurs ramifications particulières.

“ Ces tumeurs ganglioformes, ou Ganglions, different plus ou moins en Volume, en couleur & en consistance; & on les peut regarder comme autant d'origines ou des *Germ*s disperses de cette grande paire des nerfs *sympathiques*, & par consequent comme autant des petits *Cerveaux*.” WINSLOW Expos. Anatom. p. 462. 4to. edit.

Super omnes nervos, intercostali, Ganglia sunt frequentissima, in cervice quidem tria; in thorace, lumbis, & pelvi tot, quot

SECT. examining what is particular and peculiar
II. in the motions of Parts to which these
nerves are distributed, we shall probably
be led to the uses of Ganglions.

THE muscular substance of the heart, has its principal, or rather all its nerves, from the intercostals; which are always detached from the principal cords, below the Ganglions, and chiefly from the inferior cervical Ganglion. The few nervous cords from the Par Vagum, or eighth pair, which in the human subject, are sent towards the heart, are almost totally spread upon the Pericardium and great vessels (*b*).

IN the Abdomen, this nerve unites with the Par Vagum of the right side

nervorum ex spinali medulla propagines intercostalis accepit: tum in cordis vicinia, sub diaphragmate, circa Arteriae cæliacæ & mesentericæ originem. & circa renem passim in plexuosis retibus.
HALLER El. Phys. T. iv. p. 202.

(*b*) Ibid T. i. p. 366.

side (*i*), and they together form the SECT. great semilunar Ganglion; from which, and from other Ganglions formed in H. inferior parts of the abdomen, filaments  are distributed to the Intestines, the Liver, the Spleen, the Kidneys; and some of them descend to the Fallopian Tubes, Uterus, and other parts in the Pelvis; some of which are also in part furnished with filaments from the lumbar nerves.

THE Heart and Intestines, being wholly supplied by nervous filaments detached below some remarkable Ganglion, we must enquire what is peculiar in the motions of these parts, or in their structure: But the motions of the Heart and Intestines are remarkable, and exactly similar, in being both involun-

C tary,

(*i*) WINSLOW Traité des nerfs, No. 141.—The reader is also desired carefully to examine the 23 Table of VIEUSSENS' neurographia, which represents the course of the great sympathetic nerves with their ganglions and connections.

SECT. tary, or not liable to be either stopt,
II. renewed, or in any way controuled
— by the Will.

THOUGH it be very certain, that these motions are excited in the heart by the gentle stimulus of the Blood upon the internal surface of that organ; and in the intestines by that of the secreted liquors, and of the food taken in; of which stimuli, these parts have the quickest and most exquisite perception; yet this being ordinarily not so strong, as to make us conscious of its action, much less painfully so, can hardly be supposed to render these motions quite uncontroulable by the Will, without some other efficient cause (k).

ANATOMY

(k) In an excellent explanation of the *vital and involuntary motions of animals*, by a learned professor and ingenious writer, in whose death the medical world has sustained an irreparable loss, it is remarked with the acuteness proper to this excellent author; “ I imagine, that the mind’s *want of power* over the motion of “ the Heart, is not only owing to its being continually acted “ upon

ANATOMY discovers no peculiarity SECT.
in the muscular structure of these parts II.
likely to account for this, and excepting —
in their nerves having Ganglions, which
seem indeed almost appropriated to
them, no anatomical difference has been
observed, no mechanism, which these
parts have, more than those muscles
which are subject to the direction of
the Will.

MAY we not then reasonably con-
clude, that Ganglions are the Instru-
ments, by which the motions of the
Heart and Intestines are from the *ear-
liest* to the *latest* periods of animal life,
rendered uniformly involuntary; and that
this *is their use?* which they subserve
by a structure indeed unknown to us

C 2 (yet

" upon by a stimulus, but in part to an original constitution; and
" that tho' we should suppose this organ for a little while free
" from every degree of irritation, yet the mind by an effort of
" the will could not move it." WHYTT's Essay on the vital and
involuntary motions of Animals, p. 316. I hope in this Essay
to point out the *Constitution*, here ingenuously hinted at.

SECT. (yet evidently different from that which
II. usually obtains in nerves), no less than
~~—~~ that of the Brain, tho' it seems not im-
probable, the first may have some ana-
logy to the last.

THIS Conclusion concerning the use of Ganglions, is supported by every truly parallel instance. Thus the motions of the *Uvea*, or *muscular circle of the Pupil* of the Eye, ever contracted or dilated, as the Eye is more or less irradiated with light (*l*), are as much *involuntary*, as those of the Heart itself; though some unnecessary distinctions have been made concerning them, of which we shall afterwards take notice; and it is known to Anatomists, that the muscular fibres of the *Uvea* are supplied by nerves from the *lenticular Ganglion*, which seems formed solely

(*l*) Dilatation is the *Rest* or natural State of the Pupil, as Contraction is its *Action*. It dilates in an obscure light and when the Eye is directed to distant objects, and contracts when directed to near objects, and when a brighter light strikes upon the Retina.

solely for the use of that muscle, and SECT.
for that purpose (*m*). II.

WHEN we consider that the nerves, which are more immediately ministerial to the Soul (*n*), and convey impressions of external objects to it, have no Ganglions: that they are never found upon the Olfactory, Optic, or Auditory nerves and that they are as rare upon the

(*m*) See WINSLOW's description of this Ganglion, *Traité des nerfs*, No. 22, 23, 24. It is known by the Synonymous names of Ganglion lenticulare, Ciliare, and Ophthalmicum: the following is Baron HALLER's accurate description of it, " *Tertii Paris*
 " *ramus, vel reliquus truncus, est radix præcipua crassa brevique*
 " *ganglii, eademque extrorsum incedit, inque nervo optico, sub*
 " *musculo abductore, efficit Ganglion ciliare sive ophthalmicum*
 " *ovale, perpetuum, perminutum. Est ubi id a solo tertio nascitur,*
 " *neque deesse unquam vidi, neque duo, aut plura fuisse, ut superi*
 " *aliqui habent:—Nervi quinti paris ramus primus ophthalmicus*
 " *dicitur, edit ramum, euntem in Ganglion ciliare, Ex eo ganglio*
 " *furculi tendunt in uream, fibrarumque radiatarum partem aliquam*
 " *sed exiguum faciunt.*" HALLER *Elem. Phys.* p. 427—429.

(*n*) *Nervos qui sensibus ancillantur, ut olfactios, opticos, auditorios, aliosque nullis Gangliis munitos esse. Sunt enim sensus in corpore quasi quædam viæ ut Tullius ait, ad oculos ad aures ad nares a sede animi perforatæ; nulla idcirco in iis aut repagula, aut incitamenta addenda, vel interponenda erant.* J. MAR, LAN-

cis in *Dissert.* citat.

ESSAY ON THE USE OF

SECT. the nerves instrumental in voluntary motion, as they are constant and numerous in parts whose motions are independent of our Volitions; we have in this case the firmest grounds of belief, that Ganglia, on the latter, are placed as checks to the powers of Volition, and that the former are exempted from them, because they would have interrupted and prevented the determinations of the Will, from reaching the parts intended to be subject to it, and upon sensory nerves, would have rendered the notices we receive much less distinct perfect and acute than they ought to be.

THE left nerve of the eighth pair, distributed to the Stomach, and probably the cause of the distinct and exquisite sensation of that organ, and of its remarkable sympathy with the Head, seems also principally concerned in transmitting

mitting the sense of hunger to the SECT. mind, and therefore may be considered as a sensory nerve. This notion seems proved by, and in its turn throws light upon, those Experiments made by the most celebrated Anatomists, in which the eighth pair of nerves was cut asunder or tied in Brutes, and by which the functions of the Stomach were most manifestly disordered (*o*). The latest and best Anatomists agree there is no Ganglion found on this nerve, between its origin and the Stomach, where it is chiefly spent (*p*).

IF Ganglions were not intended to check, and did not actually limit the powers of Volition; the Diaphragm had

(*o*) " *Nervo Octavi Paris dissecto, Vox sublata est, & respiratio facta gravior, & concoctio ciborum destruicta, & cibus in Ventricum non venit.*" MORGAGNI in Comm. Bonon. & de Causis & Sedib. Morb.

" *Nervo Octavi Paris ligato, respiratio difficilis, vox sublata est, ciborum horror, vomitus, ventriculus foecibus plenissimus, " demum*

SECT. had probably been entirely furnished
II. from the Intercostals, as most of the
— parts in the Thorax above it, and in
the Abdomen below it, are. But as the
motions of this muscular membrane
were to be controllable by the Will,
we find peculiar nerves, namely, the
Phrenic, which are destitute of Gang-
lions, sent to it from a great distance.

“ demum cibi omnino in Ventriculo ita corrupti, ut solent crassis
“ in intestinis esse.” BRUNNERI nepot. Exp. in HALLER
Elem. Phys. Tom. iv. p. 324.

(p) “ Nervi anastomoses inter se ut vasa, frequentes faciunt,
“ & in concursu ramorum ex diversis truncis ortorum imprimis
“ Ganglia reperiuntur. In sensoriis unice nervis non reperiuntur,
“ & nulla sunt Octavo, Phrenico, nervis artuum.” A. van
“ HALLER Prim. Lin. Phys. No. 377.

SECTION III.

Anatomical Objections stated, and answered: our doctrine supported by Experiments.

THUS far have I stated the facts SECT. and arguments which tend directly to prove the doctrine I have advanced concerning the uses of Ganglions. And though I am sensible, they may not have such force, and far less such advantage of arrangement, and of authority, as to compel conviction, and are rather likely to satisfy those, who, laying aside prejudices of various kinds, are candidly disposed to give Truth that peaceful reception which it so seldom has met with, than to stand the rigorous test of a captious Controversy:

D

I am

SECT. I am, notwithstanding, persuaded that
III. my main conclusion will be found to
have a considerable weight of probability, yea, evidence in its favour, when weighed against those objections which may be brought against it, and those difficulties from which I am conscious it is not exempt. These however are chiefly such as arise from our imperfect knowledge of the nervous System ; a terra incognita, which remains to immortalize the name of some future discoverer in Anatomy.

IT is well known, for instance, and it is almost the only objection of any weight, to which our doctrine is liable, " That all the nerves sent from the spinal marrow, have Ganglions where they send off the filaments which communicate with the Intercostals (q)." The concurrence of Facts in favour of our

our doctrine, render'd it highly probable SECT.
that these Ganglions respected exclu- III.
sively the great sympathetic nerves, and
that they were the first checks to the
usual powers of Volition, and af-
fected only the filaments sent to the
sympathetic nerves, leaving the other
nervous filaments of the spinal nerves
fit, and free for the conveyance of the
commands of the Will, as in fact, they
are chiefly distributed to muscles under
its power and direction; but it did
not till lately occur to me that this
might be determined and proved one
way or other by experiments.

IT is allowed by Physiologists, that
when any nerve is irritated, the muscle
it goes to, or if it is a large nerve, or
bundle of nerves, all the muscles sup-
plied from them, are by that irritation
violently convulsed. (See Prop. 5—6.
§ I.

SECT. If then, it shall appear, that irritations and injuries of the spinal marrow (from which the intercostal, or great sympathetic nerves which supply the Heart and Intestines truly arise, as well as those nerves distributed to the limbs), occasion violent convulsions of the limbs, and yet, do not in the least affect the Heart and Intestines, parts the most irritable of any in the Body ; as will indeed be manifest by the following experiments : the difference will probably be accounted for from the intervention of Ganglion after Ganglion, constantly found betwixt the spinal marrow and the heart and intestines : The subtilty of experiments in determining what no Microscope or anatomical knife would detect and ascertain, will be acknowledged, and the unprejudiced inquirer into nature, will perhaps be led to ascribe those uses to Ganglions which I have done.

I. ON the 4th of *March* 1767, a SECT.
Kitten a week old had its head cut off III.
betwixt the first and second vertebræ 
of the neck : The Thorax was opened
with all expedition, and the heart laid
bare to view, and observed for some
time, that any difference might be
more certainly noticed : After the Ani-
mal ceased to move its limbs, I touch-
ed the spinal marrow with a probe,
immediately the extremities of the a-
nimal were all strongly convulsed, but
the heart alone, seemed unaffected, and
continued to move without acceleration,
or any degree of alteration whatsoever
(r).

BETWIXT

(r) *Convulsiones totius Animalis, ab irritata medulla spinali
“ natæ, cordis motum non fuscitant.” HALLER Elem. Phys.
T. ii. p. 205.*

These experiments were tried, and their events as here related
observed, long after the first draught of this Essay had been sent to
the Royal Society. I therefore appeal to such Persons as may chuse
to repeat them, disagreeable as they are, whether I misrepresent
them through prejudice, or not.

SECT. BETWIXT this time and *April 10*, I

III. repeated the same experiment upon
half a dozen Kittens still younger than
the first ; upon opening the thorax the
heart beat at least seventy strokes in
a minute.

WHEN the heart beat only forty in a
minute, or thereabouts, I began gent-
ly to touch the spinal marrow with the
point of a probe, and the limbs were
immediately convulsed, but the heart
not in the least affected.

I SLIT open both the ventricles of
the heart, so as to let out all the blood
they contained, and instantly the heart
ceased to beat (though before the blood
is thus removed, its pulsation continues
very long in Animals so young, espe-
cially of this kind), but the auricles
which were not opened, and therefore

were

were still stimulated by the blood, beat SECT.
on.

III.

AFTER this preparation in several of these Animals, I thrust the probe into the spinal marrow, but the heart nevertheless continued in perfect rest and inaction; though when its substance was pricked with the point of a knife, it might still be made to contract.

BUT though the heart and intestines remained equally unaffected in all the trials I made, by thrusting the probe into the spinal marrow, the following Convulsions occasioned by it deserve particular Enumeration.

ALL the limbs were violently convulsed.

THE muscles of the back were convulsed, and the spine bent as in the Opisthotonus.

THE

SECT. THE intercostal muscles were all
III. contracted, and their natural action,
that of drawing all the Ribs nearer
each other and upwards, was rendered
a matter of ocular demonstration.

THE Diaphragm was contracted
strongly, notwithstanding the Phrenic
nerve of one side, was divided, in
making similar experiments by pricking
and stretching it; which, by the way,
constantly occasioned a convulsive con-
traction of the Diaphragm.

EVEN by plunging the probe into the
Brain, after the head had been cut off
some minutes, the Eyes, Tongue, and
lower Jaw were made to move. (f).

I HAVE

(f) In an account of the Execution of *Mary Queen of Scots*, it is declared that her Lips stirred up and down almost a quarter of an hour after her head was cut off. *BALLARD'S Memoirs of Learned ladies of Great Britain*, p. 166.

I HAVE made the same experiments, SECT.
with like consequences upon Frogs. III.



BUT these experiments must be made within less than a quarter of an hour after decapitation ; half an hour after, no such effects follow the destruction of the spinal marrow. And they succeed best by previously opening the ventricles of the heart : By the way, the irritability of the muscles continues not longer than the power of exciting contractions in them by irritating the corresponding nerves.

EXPERIMENTS, similar to these in event, have been made on Frogs, by STUART, Bar. HALLER, Dr. WHYTT, and many more.

“ WHEN I opened (says the last
“ of this ingenious Triumvirate) the
“ Thorax of a Frog, immediately af-

SECT. " ter decollation, and destroying its
III. " spinal marrow, I observed its heart
— " beating after the rate of sixty in a
" minute, which is four or five pulsations less than I have generally seen
" the hearts of Frogs make in that
" time, when the Thorax was opened
" without decollation (*t*)."

II. " SOME young Gentlemen, having hanged a Cat, till she was quite dead, opened the Thorax and observed only a tremulous motion in the heart, which soon ceased, but was renewed by pricking it with a sharp instrument: after this by squeezing the Cardiac nerves downwards, or otherwise irritating them, the heart was made to perform two or three pulsations, which it continued to do for a considerable time,
" when-

(*t*) See WHYTT's Exp. on living and dying Animals, Ed. Ph. and Lit. 2 Vol. p. 282, and WHYTT's Physical Essays.

" whenever the Cardiac nerves were SECT.
 " thus stimulated (*v.*)" These Experi- III.
 ments were made with no kind of view ~~to~~
 to the doctrine which I shall endeavour
 to shew they enforce and support.

III. ANIMALS are killed, some sooner, and others, especially of the cold kind (as Frogs and Tortoises, on account of the largeness of the spinal marrow) much later, by cutting through the spinal marrow near its origin. The cutting thro' the intercostal nerves, or the tying ligatures upon them, is also sooner or later *fatal* to the Animals the experiments have been tried upon, by finally destroying the *Heart's motion*, and instantly, in a wonderful manner, *weakening and disturbing its motions* (*w.*).

E 2

THESE

(*v.*) Essay on the vital and involuntary motions of Animals, by WHYTT, p. 355.

(*w.*) Octavæ conjugationis nervis, una cum nervis par intercostale constituentibus, circa cervicem, ex transverso recisis, animal

SECT. THESE Experiments prove, that the

III. Ganglions on the spinal nerves, do not hinder the irritation of the spinal marrow from causing convulsions in the voluntary muscles: And that the Ganglions (1) do, in all probability, hinder that cause from acting (as without their intervention it must have done) upon the heart, by means of its nerves, chiefly arising from the spinal marrow originally: And therefore it seems evident, and beyond a plausible conjecture, that the Ganglions on the spinal nerves, relate exclusively and solely to the inter-

costal

mal illico languore futuræ mortis prænuncio afficitur, *tremulus motus patitur*, vires illius sensim labascunt, & intra 24 circiter horas, vita destituitur, quæ per illud breve temporis spatium, spiritu animali sustinetur, quem medulla spinalis, & nervi plexus intra medium & infimum ventrem latitantes naturalibus & vitalibus partibus suppeditant. Vieussens neurographia, cap. iv. Lower de Corde. HALLER, Elem. P. T. i. p. 464—5. And MORGAGNI de Sedibus Morb. Ep. xix. art. 23. describes the encheirefis, or manner of making this experiment, and observes, it is impossible in Brutes to cut or tye the Intercostal nerves or par vagum, separately, without dividing or tying both together; a fact, which has not been always considered in reasoning upon this experiment.

costal or great sympathetic nerves, for SECT. the purposes I have endeavoured to III. prove: This doctrine derives farther confirmation from experiment (2), as we thereby see that the heart may be made to move, as all other muscles may, by irritating or squeezing its proper nerves, below their Ganglions: And, that the motions of the heart cannot long continue, in warm animals especially, after the division of their principal nerves (3), which shews the dependance of the heart (*Prelim. Prop. 6*) ultimately, as that of all other muscles, upon its proper nerves, and their connection with the Brain.

IT is objected, “ That one or two Ganglions, are often observed upon a filament of the second great branch, and another upon the third branch of the fifth pair of nerves.”

SECT. THE constancy, and if, I may so express it, the solicitude with which all
III. parts whose motions are involuntary,
parts whose motions are involuntary,
are provided with nerves, furnished
and beset with Ganglions; and the great
scarcity of them on nerves detached to
muscles subject to our Volitions, and
the total want of them, on the sensory
nerves, sufficiently bespeaks their general
destination and use; notwithstanding
a few seeming exceptions: seeming
I say, because those few alledged as
such, are not permanent parts of animal
structure, or constantly found. As
their appearance is in some measure
accidental, we have reason to suspect
them to be rather morbid Phænomena,
than organs of great importance in the
animal system: The Ganglia in particu-
lar of MEKELIUS, found on the second
and third branches of the fifth pair of
nerves, are very essentially distinguished
by Baron HALLER from other Gang-
lions;

lions; particularly the Ganglion Oph- SECT.
thalmicum, which he says is constant III.
and perpetual; whereas the other Gan-
glions of the fifth pair are not so, for
he remembers to have examined Bodies,
in which they were wanting (x). But
supposing the utmost in favour of the
constancy of these Ganglia of the fifth
pair; the nervous twigs on which they
have been observed, being chiefly di-
stributed to the salivary and mucous
Glands, about the jaws, tongue, palate,
throat, and nostrils; may they not be
supposed to have some use in glandular
secretion? For we see the glandular
parts in the Abdomen, are supplied by
the

(x) These Ganglions have been seen on a twig of the supermaxillary branch of the fifth pair, with respect to which Baron HALLER says, " Memini in aliis Cadaveribus eodem loco nullum " adfuisse." El. Ph. T. iv. p. 213. The same he observes with respect to another Ganglion, sometimes seen on the lingual Branch of the third great Branch of the fifth pair, the maxillaris inferior, it was sometimes not found. Ibid. T. iv. p. 218—219. The Pterygoid Branch on which a third Ganglion has been seen, sends one or two twigs to unite with the intercostal nerves at its origin.

SECT. the great sympathetic nerves, as well as

III. the muscular fibres of the heart and

intestines.

IT has likewise been objected, " That
" the great sympathetic nerves send
" some branches to parts, under the
" controul of the Will, as the Pharynx
" and Diaphragm, as well as to the
" heart and intestines, not subject to
" that controul."

IT is well known that tho' the Pharynx derives some nerves from the great sympathetic nerves ; its most considerable supply of nerves comes from the eighth pair : and the Diaphragm is rendered paralytic by tying or cutting the Phrenic nerves distributed to it ; which shews that its motions have very little dependance on the minute filaments which it receives from the great sympathetic nerves. There are other parts,

motions in these parts besides those of SECT. the voluntary kind ; their motions being of the *mixed* kind, sometimes being *involuntary*, at others voluntary. There are other parts also, as well as these now named, whose motions are of the mixed kind ; and it is remarkable that all of them have two different kinds of nerves ; namely, some without Ganglions to subject them to the powers of Volition ; and others that have Ganglions to supply the involuntary motions of the same parts. Thus the Diaphragm moves, when we are a-sleep, and when we are awake, though not quite so often, and continues to move, tho' less frequently, even during a profound Apoplectic Fit. In like manner, we can raise the Pharynx by an effort of the Will, yet in the action of Deglutition, its motions are chiefly involuntary from the stimulus of the food passing down the gullet.

ESSAY ON THE USE OF

SECT. let (y). In the involuntary motions,
III. the stimulus which excites, regulates
~~the~~ their intenſeness and continuance: In
the voluntary motions, the Will excites
and regulates them all.

WE are not to imagine, nor do I know that it is generally supposed by Anatomists, that wherever the nerves unite, their medullary substance either decussates, or is so intimately mixed, as is reasonably supposed to be the case in Ganglions, by most Anatomists, from GLISSON down to HALLER: We know at least, that this is far from being the case in the *Optic* nerves; for though they unite, and were supposed to cross each other, the contrary appears by Observations, made, in the bodies of Persons who were blind of one eye from a fault of the *Optic* nerve; the nerve of the

(y) See Essay on the Vital and Involuntary motions of Animals.

the affected side only being wasted, SECT. while the other was large and plump III. (z). And we may justly infer, the ~~un~~ *Plexiform unions* of the nerves, distributed to the superior and inferior extremities, not to be more intimate, nor intended to serve any such purpose as Ganglions, since these nerves are equally motory and sensory; no other nerves being distributed to the skin, the organ of touch, but from the sub-division of these Plexuses.

(z) See the Anatomy of the nerves in general by a late justly celebrated professor of Anatomy, Dr. MONRO, Sen. p. 356. and No. 23. SANTORINI OBS. ANAT. 63. VESALII Anatom. Lib. iv. C. iv. "VESALIUS, AQUAPENDENS, VALVERDA " aliquando observarunt, toto ductu divisos nervos " mansisse, & eum tamen in quo sic confinxit VESALIUS de visu " nunquam conquestum fuisse, visuque præstanti semper valuisse." "MORGAGNI de sedib. Morb. Ep. xiii. Art. 7.

SECTION IV.

*Physiological difficulties obviated :
Conjectures concerning Irrita-
bility, &c.*

SECT. IV. **I**F these Anatomical difficulties do not subvert our doctrine, the following of a Physiological nature, it is presumed, will not be more formidable; or perhaps, may become arguments in its favour, when properly considered.

IT has been objected, “ That if the Ganglia intercept the communication between the sensorium commune, and those parts whose nerves are derived from them ; they ought not only to intercept the commands of the Will,

“ Will, and render the motions of SECT.
“ these parts not voluntary, but they IV.
“ ought also to prevent the impressions —
“ made on the nerves of these parts,
“ from being conveyed to the sensorium
“ commune, *i. e.* these parts ought to
“ be insensible: the contrary of which
“ is true. For example, the Intestines,
“ whose nerves come from Ganglia,
“ are among the most sensible parts of
“ the body: and if the uneasy sen-
“ sation in the Lungs, in Asthmatic
“ cases, was not conveyed to the sen-
“ forium commune, how could the
“ Will redouble the action of the Dia-
“ phragm and the intercostal muscles ?”

I. To this it may be answered, That an Anastomosis, or new arrangement of the nervous filaments which appears to take place in Ganglia, may intercept the efforts of the Will, and also render the sensations of parts wholly supplied with

SECT. with nerves from Ganglions less de-

IV. terminate and precise than in other

parts, which indeed is a fact; yet, without rendering such parts totally insensible. Paralytic Diseases show, that the nerves may be so affected, as to be incapable of conveying the commands of the Will, and yet remain sufficiently capable of reconveying sensible perceptions. In the Paralyses which are most frequent, the parts rendered perfectly immovable by the disease, have as quick a feeling as those that are moveable by the Will; and what deserves attention, are often moved involuntarily, especially upon the application of any painful stimulus: and it is observable too, that paralytic limbs, which are not to be moved by our Volitions, are often called into action, when the paralytic person is suddenly thrown into any violent passion; just as we observe the same cause to produce extraordinary

com-

commotions in the Heart and Intestines, SECT.
&c. though the Will, coolly exerted, IV.
has no power over these parts. 

II. VARIOUS observers have shown that the feelings of the organs, whose motions are involuntary, are by no means exact, nor always acute. We have it on the authority of HARVEY (*a*), confirmed by Baron HALLER, that the heart tho' highly irritable, is when touched, very dully sensible, as has also appeared in wounds and contusions of this part (*b*). HALLER asserts that the lungs, liver, spleen, and kidnies, all supplied from the great sympathetic nerves, have been cut in pieces, and yet the animal seemed to feel no pain. And (which is a proof less liable to exception) operations and diseases in the kidnies, and ulcers in the lungs being but

(*a*) HARVEY de Generatione Animalium.

(*b*) Phil. Trans. Vol. LII.

SECT. but little painful, show the feelings of.

IV. these parts not to be exquisite (*c*).

III. THE Stomach, which has a very large portion of the eighth pair of nerves bestowed upon it, loses its sensibility and contractile power so perfectly by ligatures of this nerve, that the food neither passes down the œsophagus, nor is concocted in the stomach, and by spontaneous corruption there puts on the appearance of the fæces themselves so fætid in the large intestines (*d*). 'Tis, in consequence of the sensibility which the stomach derives by means of this nerve, along with its peculiar organization, that the stomach becomes the principal seat of hunger; and, to use the words of a celebrated writer, " As it is affected with a more disagreeable sensation, when we have wanted food for any considerable time, than the " guts;

(*c*) HALLER's celebrated Essay on sensible and irritable parts.

(*d*) See MORGAGNI, & VIEUSSENS locis citatis.

" guts; so likewise it is more sensible SECT.
 " of an agreeable feeling, from grate- IV.
 " ful food: and in these respects it ~~is~~
 " may be said to be *more sensible* than
 " the intestines (*e*). .

IV. A LESS precise feeling the intestines certainly have; and tho' in many instances they are the seat of exquisite pain, yet in consequence of the *connexions* of the nervous filaments in the Ganglions, any painful disease seated in the intestines, or in the other Viscera contained in the Abdomen, is by sensation less determinable to its particular seat, or rather is more apt to affect the parts adjoining, than diseases of a painful nature which are seated in the stomach itself, and in other parts whose nerves are not supplied with Ganglions (*f*). G AND

(*e*) See WHYTT's Path. Essays, p. 155. first Edit.

(*f*) Ut anima non adeo accurate locum dolentem distinguat,
 sed obiter utcunque, et aliqua latitudine. A. V. HALLER EI,
 Phys. T. iv. p. 497.

SECT. AND this leads us to a natural solu-

IV. tion of that sympathy, that *intercommunion of sensations*, or that *imputation of sensation*, which so frequently takes place in the Cholic, inflammation of the Intestines, and nephritic complaints, and other diseases of the contained parts of the Abdomen, from which some writers (*g*) have very conclusively argued for the necessity of such a communication of the nervous filaments in Ganglions, as appears indeed, to take place in them, and which among other important uses, seems the occasion of many of those sympathetic sensations in the lower belly so frequently taken notice of, and so difficult to be explained (*b*). IT

(*g*) ZINN. de oculo, citat. HALLER, El. Phys. T. iv. p. 321.

(*b*) The celebrated WHYTT's objections to particular sympathies, arising from a connexion of nerves in Ganglions, seem inconclusive: for, says he, such a communication as is supposed in Ganglia to occasion sympathy would cause a *confusion* in our sensations, as well as in the *motions* of our muscles. With respect to *sensation*, we have seen that *confused* or *indeterminate* *sensation* is proper to parts whose nerves arise from Ganglions; and that the muscular motions of these parts

are

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IT is objected also, " That every SECT.
 " voluntary muscle in the body becomes IV.
 " involuntary when it is strongly stim-
 " mulated: for example, the *Acceleratores Urinæ*, are quite voluntary in
 " the Action of expelling the Urine,
 " but act involuntarily in expelling the
 " semen."

G 2

WHEN

are not regulated by the Will, but by the application of an irritating cause; and therefore, instead of proving that sympathy in the Abdominal viscera does not arise from Ganglions; they render it likely that it does. The Mind undoubtedly feels sympathetic as well as all other sensations only at the origin of the nerves in the Brain, where the Soul sits enthroned: Yet facts incline me to think with WILLIS, VIEUSSENS, HALLER, and MONRO, that sympathy depends in many cases upon the connexions of nerves in their course, as well as at or near their origin.

It is well known, that an irritating cause acting upon a nerve in any of the limbs, will sometimes extend its efficacy as far back as the Brain and occasion *convulsions*, or Epileptic paroxysms affecting the whole Body sympathetically; at other times it only affects some particular parts of the Body, as in the case of the locked Jaw, spasmus Cynicus, and various other instances which I purposely omit. In like manner any violent irritation, which by its stimulus affects any of the filaments of the intercostal nerves up to their origin in their respective Ganglions, will also act by consent upon, and affect all the filaments which have their common origin in such Ganglions: And hence sympathetic symptoms will arise in the first place, in the parts of the

Abdomen

ESSAY ON THE USE OF

SECT. IV. WHEN we consider the state of the Soul and Body under any violent passion of mind, we find the usual operations of the Soul itself are not only disturbed, but those parts of the Body too, which the Will cannot controul, are now agitated by the storm; for every one has experienced that the heart and Viscera in general are vehemently affected by strong passions: the mind is in like manner violently re-acted upon by very strong bodily sensations; for it is well known that muscular parts which are ordinarily subject to our volitions, cease to be so, if any part is stimulated

Abdomen and Thorax supplied by the great sympathetic nerves, and afterwards in the rest of the Body, nearly in the order in which these nerves are connected with the rest of the nervous system. The Reader will find that the celebrated DE HAEN has adopted the WINSLOWAN opinion, that the Ganglions are the origin of the intercostal nerves, and attempts with great probability to explain from thence the singular paralytic symptoms sometimes left by Saturnine Cholic. This general account of sympathy is supported by so many facts, that I think one may safely venture to foretel, it will derive proof and confirmation from such new discoveries as will advance the knowledge of the nerves, and enable future ages to see things clearly on this subject, which at present are dark and inexplicable to us.

mulated by exquisitely pleasing, or excessively painful sensations; under such a stimulus they are necessarily contracted or convulsed. But, it is not therefore to be concluded, that the gentle stimulus of the Blood, on the surface of the Heart, and of the air, food, and gastric juices, on the Intestines, of which the mind has no conscious perception at all, much less a disagreeable one, can lay it under any similar necessity, as some have argued. This objection can have no force against our doctrine, however it may recoil upon that of others; as all voluntary muscles whatever may be excited to contractions by irritations excessively pleasing or painful; the contractions from such causes being involuntary, necessary, and uncontrollable: But the stimuli that affect the Heart and other parts, whose motions are naturally involuntary, are not of this class, nor of this strength; and indeed,

SECT. IV.

SECT. deed, are so little perceived by the mind
 IV. as to lay it under no such necessity, as
— in the instance objected. Those on the
 contrary, who, observing that we are
 not conscious of these motions, infer
 from thence that the self-thinking in-
 dividual or human Soul, is not the real
 author of them ; and who instead of re-
 ferring them to unknowing Nature, at-
 tribute them to its great Director, seem
 to me, to reason very conclusively (i).

To

(i) See BAXTER's Inquiry into the nature of the human Soul. A performance in which the justest notions of the Soul's authority in and over our Bodies, and of the divine government co-operating therein, and controlling universal Nature, are excellently deduced and supported upon the foundations of sound reasoning and true Philosophy.

" The great mysterious Being, who made and governs the
 " whole System, has set a part of the chain of causes in our
 " view ; but we find, as he himself is too high for our compre-
 " hension, so his more immediate instruments in the universe
 " are also involved in an obscurity that philosophy is not able to
 " dissipate ; and thus our veneration for the supreme Author is
 " always increased in proportion as we advance in the knowledge
 " of his works : as we arrive in philosophy towards the first
 " cause, we obtain more extensive views of the constitution of
 " things, and see his influence more plainly : we perceive that
 " we are approaching to Him, from the simplicity and genera-

" lity

To what other immaterial power SECT. can we refer the support of the vital IV. motions, which have for their cause ~~the~~ irritability ? a principle or cause not immediately extinguished by Death itself, and which exists in the heart and intestines, not only, when they are separated from the Head, and the rest of the Body ; but when divided into a thousand parts, each piece retains it.

Is it then an inherent property of muscular fibres ? Sound Philosophy teaches us, that activity in matter can never be inherent, but must be impressed by some immaterial, and as seems probable, in the present case, active percipient power.

As irritability exists in muscular fibres separated from the Body, the Soul does

" lity of the laws or powers we discover, from the difficulty we
" find to account for them mechanically, from the more and more
" complete beauty that appears, &c." MC. LAURIN's View
of Sir ISAAC NEWTON's Philosophy. Cap. I.

SECT. does not seem to be that active power.

IV. For the Soul is seated in the Brain only, ~~and~~ and is acted upon, and puts muscles in action by means of nerves (*Prop. 4, 5.*) continued from the Brain. Hence when the nerves are compressed, tied, or cut through, the Soul loses its power, and yet, Irritability remains, even in muscles of the voluntary class. Those that are involuntary, and over which the Soul has no authority at any time, possess this property nevertheless, in the most eminent degree.

DETRUNCATIONS of the Body, diminish not the faculties of the Soul, which remain perfect unless the Brain be injured. The Soul is not a divisible or discerptible substance.

IRRITABILITY therefore, tho' capable of being occasionally excited by the

the soul, as a kind of irritant, through SECT. the medium of the nerves, seems to IV. have a different percipient agent for its cause, and to be derived only from that immaterial Being, who created all Bodies, is the source of all active force that appears in them, and presides over the universal frame of nature.

I SHALL not enlarge this digression, by endeavours to explain, how the Soul acts upon the *nerves*; and how, by means of these, the irritable muscular fibres, are by an act of the Will made to contract: how the more violent agitations of the Soul, by the medium of the nerves, affect the irritable, but involuntary vital organs. What the nerves contribute towards the contractions of *muscular fibres*, and how far their efficacious energy is necessary to such contractions (*See Prop. 6*).

SECT. IV. THERE is in all fibres of animal Bodies, even those of the cellular kind, a natural contractibility and power of retraction, which appears equally in living and dead Bodies, whether warm or cold.

MUSCULAR fibres possess this power of retraction along with that of irritability, which seems proper to them alone in their living state; at least, it vanishes soon after Death, and is not capable of being excited when muscles are thoroughly cold in consequence of death (*k*).

This property of irritability in muscular fibres, seems not only capable of being excited and regulated by means of the nerves, but is also manifestly capable of increase by nervous power: yet Poly-

pes,

(*k*) Te decisa sum, Laride, dextera quatit,
Sesquianulque micant digiti, ferrumque retractant.

Virg. Aen. x. 395, 396.

pes, and perhaps some of those plants SECT. called sensitive, are highly irritable, tho' IV. said to be destitute of nerves: if this assertion be sufficiently grounded, it would then seem that irritability has no necessary dependance upon nerves, but may exist in muscular fibres without them. This property, however, in muscular fibres, in connexion with nerves, is productive of voluntary motion at the nod of the mind; and is also productive of involuntary motion by the action of a stimulating fluid upon the nerves spread over the internal surface of the heart and intestines; so that, tho' we may have animals, formed without nerves, highly irritable, and active, in consequence of this irritability: yet, in such animals as have the nervous and irritable systems united; the dependence of irritability upon the nerves, in consequence of that union, seems so

SECT. great as not easily to be, even in imagination, separable from them.

WHAT we know only with certainty is this single fact, that the nerves connect the Soul and the Body together: That by them the Soul acts, and is acted upon: How these things are performed is intirely unknown to us, and will probably so remain, at least, till new discoveries are made in the nervous system.

THOUGH no positive doctrine of any great importance has yet been educed from the late researches and experiments, concerning the nature of the irritable fibres of animals and their nerves; these researches show that many things hitherto firmly believed concerning them, are merely supposititious. From the effects of stimuli on the nerves and muscular fibres, from the excited

con-

contraction bearing no proportion to, SECT.
and often far exceeding, the force with IV.
which the stimulus was impressed ; in
fine, from the evident marks of life, and
something resembling sensibility in these
contractions, it seems clear, that the
origination of muscular action is not
likely to be accounted for by any hy-
draulic law or mechanic power : And
the suppositions of subtle fluids, called
Spirits, flowing in nerves as canals, or of
an Electric Aura *conducted* by them, or
of vibrations like elastic strings, are not
only assumed without proofs, but are
all equally inapplicable in all points to
appearances, and insufficient to account
for the communication of motion from
the brain to the muscles.

To unfetter the mind from error,
prepares it for the investigation and dis-
covery of truth. A real conviction of
the imperfection of our knowledge of
the

SECT. the nerves, which has of late been gain-

IV. ing ground and acquiring strength from

many laudable attempts to remove those
defects, affords a happy presage that
the acquisition of true and important
knowledge in this dark region of ani-
mal structure, is not far off. Yet we
must remember, that science may be de-
fective, when it is not illusory or totally
false. For in the first gleams of light,
and the first conceptions of truth itself,
concerning subjects that border on the
limits of human knowledge, difficul-
ties will abound, and the darkness, which
terminates our prospect, must necessa-
rily cloud and obscure its confines.

LASTLY, it has been objected, That
" tho' the motions of the Uvea are in-
" voluntary, from light affecting the
" eye; they are truely voluntary,
" when it contracts in order to the
" distinct vision of an object placed
" near

" near the Eye, whose minute parts SECT.
" we want to observe accurately." IV.



IT is an excellent *Maxim* laid down by Sir ISAAC NEWTON, That " Conclusions drawn from experiments and observations by induction, are not to be shaken by any objections but such as are taken from experiments, or other certain truths." The distinction formed in this objection is the off-spring of the School of STAHL, and has no support from experiment and obvious matter of fact; but seems verbal and hypothetical only. This will appear, if we consider that the Uvea always dilates, when the distance of an object increases, and in an obscure light. Dilatation is the natural state of the Pupil, and a faint image or weak light making but little impression upon the Retina, and a strong light and near object (which always reflects a more

SECT. more vivid image than a distant one)

IV. making a strong impression upon it, the
Pupil is more contracted by the last,
and less by the first. That the contrac-
tions of the Pupil, are never voluntary,
but always arise from sensations of the
Retina, uniformly and involuntarily, by
an invariable law, appears by experi-
ments and diseases : And hence it is,
that the Pupil constantly becomes im-
moveable and greatly dilated, when by a
Gutta serena the Retina becomes insen-
sible. The great man, to whose pre-
cious stores we have been so often in-
debted in the course of this inquiry, has
furnished experiments, which prove that
the Iris or Uvea, like all other parts
provided with nerves from Ganglions,
has but a dull degree of feeling, and is
moved intirely independent of the Will:
“ What persuades me, that the Iris is
“ much less sensible than the Retina,
“ is, that if, after having pierced the
“ Cor-

" Cornea, you irritate or cut the Iris, it SECT.
" is not therefore contracted; whereas IV.
" the least increase of light makes it ~~contract~~
" contract: which evidently proves that
" this contraction does not depend upon
" the proper sensibility of the Iris, but
" on the Retina: the Gutta serena serves
" to prove the same thing; the Iris be-
" ing no ways changed in that disease,
" any farther than it is deprived of mo-
" tion from the sensation of the Retina
" being destroyed by a palsy of the
" Optic nerve (*l*)."⁽¹⁾ And whoever will
observe the motions of the Pupil by
means of a mirrour, will find the Will
has no sort of power over them.

(1) See Baron HALLER'S Essay on Irritability, p. 31. and
Element. Phys. T. v. p. 374—378.

S E C T I O N V.

*Some Diseases considered briefly
with relation to Ganglions.*

SECT. V. **F**ROM what has been said, I think it appears, that Ganglions are organic parts of great importance in the nervous system, and animal machine. That they limit the powers of volition, will, I flatter myself, appear a doctrine fairly inferred, by an induction, little, if at all, short of being complete: we may therefore venture, upon these grounds, to consider some of the subordinate effects of Ganglions in our machine; some of which we have already hinted, and which, I doubt not, will be much more extended by those who shall succeed.

ceed me in this research : the coast is SECT.
discovered, and others I hope will ga- V.
ther its riches.

IN sleep, and in apoplexies, the external senses cease to convey impressions to the Soul ; and the exercise of voluntary motion is superseded ; but the vital functions have in these circumstances the same, and some have believed a greater, strength and vigour than before : the truth seems to be, that what is wanting in the frequency and number of Respirations and of Pulses, is made up, by their greater deepness and fulness. In sleep, this temporary interruption of sensation and voluntary motion, arises from the nervous power being exhausted, which by a few hours' rest is constantly recruited ; and with it, a state of vigilancy returns, in which the whole animal machine, its senses, voluntary as well as involuntary motions, are in complete action.

SECT. V. APOPLEXIES arise from some ex-
travasated fluid, or other cause, com-
pressing the Brain in such a degree,
as to put an end to its functions, (if not
removed) and those of external sensa-
tion and voluntary motion, depending
upon them.

IT has been a question long agitated,
why in Apoplexies, the same compres-
sion does not intercept the nervous
power, by which the *vital* functions,
and *animal* functions are both supported;
and how it happens that the heart con-
tinues to move, and the respiratory
organs to act, for a considerable time
after sense and motion in the other
parts seem to be at an end?

SOME eminent Physicians have at-
tempted to solve this question, by con-
fining the cause of Apoplexies to the
Brain only, from whence they supposed
all

all the sensory nerves, and those subservient to voluntary motion, were derived: V. and that the Cerebellum remained un-compressed, because of the strong and tense membranes, which are interposed betwixt it, and the Brain; and that the vital organs from thence were solely supplied with nerves (which is far from being true): and this, they imagined proved by some experiments, in which wounds of the Cerebellum were found to occasion immediate death in various animals.

BUT it being observed by others, that the worst wounds of the Cerebellum had sometimes healed, and that not much difference, as to danger, could be observed, betwixt deep wounds of the Cerebrum and Cerebellum: and that Foetus's at their full time have been born alive, though destitute both of Brain and Cerebellum: and lately it having

SECT. having been found that the spinal marrow may be cut through near its origin, and the eighth pair, and great sympathetic nerves divided, by which all communication both with Brain and Cerebellum is cut off, yet, to the astonishment of beholders, the heart continuing to move for many hours afterwards, this theory falls of course; and we are obliged to search out some other cause, which may account for this phænomenon, in a more satisfactory manner.

I AM not without hopes, that the doctrine we have advanced concerning the nature and uses of Ganglions of the great sympathetic nerves, will afford a natural solution of this difficult Problem. The great sympathetic nerves being truly derived from the spinal marrow, have in the numerous Ganglions proper to them, so many receptacles of nervous energy, so many sub-

subordinate Brains, which continue to SECT. dispense the nervous energy to the V. vital organs, long after they cease to ~~wave~~ have communication with the Brain ; and support the *Irritability* of the heart, which makes it so long sensible to the stimulus of the blood flowing into its Auricles and Ventricles after the rest of the machine is in fact dead : but, as the whole nervous system derives its energy from, and ultimately depends upon, the Brain and Cerebellum ; these subordinate sources of nervous energy, being at length exhausted, without a possibility of a new afflux from the brain, the vital organs at length cease to move.

THIS reasoning seems strongly confirmed by those Foetus's already mentioned, which come into the world without any Brain or Cerebellum : these generally have the medulla spinalis large enough

SECT. enough to supply the great sympathetic
V. nerves: and by these nerves, the force
— of the heart, the circulation, and deve-
lopement of the organs of the Fœtus,
are sustained in the mother's womb; for
as soon as they lose the Mother's foster-
ing heat, they die; if not dead before
their birth.

By the inter-communion of nervous energy arising from the numbers of Ganglions on the great sympathetic nerves, we understand also, how, and by what means, the vital and involuntary powers of our machine go on unimpaired in perfect Hemiplegias, which reduce one half of the animal body to a state of mere vegetative life, the muscles of one side being no longer obedient to the Will: When this is thoroughly considered, it will be found a strong proof of our doctrine: for, if the filaments of the nerves were not in-

interrupted by, and intermixed in, Ganglions, in their course from the Brain to the Viscera; but were continued threads or canals, as they ^{seem} are from the Brain to the sensory organs, and voluntary muscles; a very manifest defect must have appeared in the functions of the viscera contained in the Thorax and Abdomen, by the loss of half the nervous power distributed to them: that is, a greater defect must have happened in every Hemiplegia, than ever happens in any one.

It seems consistent with this view of Ganglions, as subordinate origins of nerves sent to the intestines, yet, ultimately derived from the Brain; rendering sensations less determinate, yet, not precluding them in an indistinct way from reaching the sensorium commune: It is, I say, natural to expect from, and consistent with this doctrine, that

ESSAY ON THE USE OF

SECT. such causes as very considerably compress the whole brain, or spinal marrow near the head, so as to intercept external sensation, will also blunt very considerably the sensation, and lessen the irritability, of the parts to which the intercostal nerves are distributed : this indeed actually happens in dangerous attacks of the Apoplexy, in which the most irritating medicines, the most violent and stimulating cathartics, in doses, which at other times would be poisonous, are often inert and ineffectual, from the unfeeling state of the Intestines : this also happens when the spinal marrow near the head is greatly compressed, of which we have a curious instance in the last volume of *London medical observations* (*m*). But in other

(*m*) See Medical Observations by a Society in *London*, Vol. iii. Art. xviii. p. 160. and M. DU VERNEY's observation in Reg. Scient. Acad. Hist. Lib. iii. DU HAMEL, p. 264. We have also curious instances of the same kind in the very useful and interesting Inquiry into the efficacy of warm bathing in Palfies, by the

other cases, where I have known the SECT. spinal marrow compressed, though less V. considerably, and at a greater distance from the brain ; this effect has not followed : when that total compression is but a little removed, and the nerves of one side only, as in the Hemiplegia, or perhaps still fewer than half the nerves, pass down the spine free from pressure ; then the intestines *altogether* recover their sensibility, and the heart continues to act with its wonted vigour ; by which we know, that by

K 2

some

the ingenious Dr. CHARLTON.—*John Waterman*, aged 34, by a fall, had the third and fourth Vertebræ of his Neck distorted. The paralytic effects of this distortion, which remained when he was admitted into the Bath Hospital, and which were soon removed by pumping upon the neck; (the Vertebræ gradually sliding back into their natural situation) were, a palsy in his lower limbs, and a monstrous distension of his belly, which was sore to the touch, and if struck on, sounded like a drum ; he was costive, and it was with the utmost difficulty he parted with his Urine. The swelling of the belly subsided by great discharges of wind from the stomach, and in proportion to its decrease, the action of the bladder and the peristaltic motion of the bowels were restored with the perfect use and feeling of his limbs, p. 58. See also Mrs. Whiby's case, ibid. p. 31.

SECT. some communication of the nerves in
V. Ganglions, analogous perhaps to an
Anastomosis, the functions of the Vis-
cera are carried on sufficiently.

I MIGHT go on, to confirm the reality of such a communication of nerves in Ganglions, by various phænomena in other diseases, which plainly point it out; and to account for the production of sympathy, in many cases, in consequence of that connexion. I might also show, that Ganglions probably have some use in Secretion, by securing a more uniform motion of the liquors in the secreting organs; but such discussions as these would lead me into a very wide and uncertain field of Physiological disputation: it would be more my inclination, by pursuing the same clue of obvious facts and experiments, to try to make some advances in the knowledge of nervous diseases, which being

so near the seat of the mind itself, afflict it more sensibly than those which affect the nerves less, and are thereby more remote from the mind: changeable besides, and intricate in themselves, they seem to have been rendered more so, by the wild and hypothetical manner in which they have been for the most part considered. The most precious truths, even on that forbidding subject, may be more within our reach than we are aware of, provided we adhere close to the method of observation in our researches, and carefully divest ourselves of prejudices arising from received Theories, which, involving the mind as in a mist, render it less apt to perceive and admit the truth: but I leave this exquisite task to those who have abilities proportioned to its importance; to the HALTERS and TISSOTS of this, and the

BOER-

ESSAY ON THE USE OF
SECT. BOERHAAVES and WHYTT'S of suc-
V. ceeding ages.

— *Nec meus audet
Rem tentare pudor, quam vires ferre
recusent.*

I SHALL therefore now finish this Essay with a recapitulation of the principal matters endeavoured to be proved in it ; and with reflections not unsuitable to my subject.

SECTION VI.

Recapitulation--final cause of our vital motions being involuntary.

TH E Ganglions, respecting their SECT. structure, may justly be considered as little brains, or germes, of the nerves detached from them, consisting of a mixture of cortical, and nervous medullary substance, nourished by several small blood vessels, in which, various nervous filaments are collected, and in them lose their rectilinear parallel direction, so that a new nervous organization probably takes place in them.

RESPECTING their uses, Ganglions seem the sources, or immediate origins of the nerves, sent to organs moved in-

SECT. involuntarily; and probably, the check
VI. or cause, which hinders our volitions
from extending to them.

GANGLIONS seem analogous to the brain in their office: subordinate springs, and reservoirs of nervous power, they seem capable of dispensing it, long after all communication with the brain is cut off. And tho' they ultimately depend upon the brain for its emanations, it appears from facts, that, *that* dependance is far from being immediate and instantaneous.

FROM the Ganglions serving as subordinate brains, it is, that the vital organs derive their nervous power, and continue to move during sleep: and, to the same cause, as well as to its greater irritability, we may refer the continuance of the motion of the heart, so much longer than that of the voluntary

luntary muscles, in perfect apoplexies. SECT. VI. From thence too, the motions of the heart receive for some time, support, even after the spinal marrow and the intercostals in their descent along the neck, are cut through: so that animals survive this experiment sometimes thirty hours, which however proves at length certainly fatal, by cutting off all communication with the prime fountain of nervous emanation.

IN a word, *Ganglions* limit the exercise of the Soul's authority in the animal œconomy; and put it out of our power, by a single *volition*, to stop the motions of our heart, and in one capricious instant irrevocably to end our lives.

HOWEVER in the dark we may be, what subordinate agents are employed by an *Almighty Arm*, to wind up, and regulate

SECT. regulate this delicate machine, and so

VI. uniformly to guide and direct, indepen-

~~~~~ dant of us, our vital and involuntary motions, we must at least clearly discern the goodness, and unerring wisdom of our CREATOR acting therein, though by ways past finding out, for our preservation and security.

BEING thus led up to this exalted truth, the natural and happy fruit of my subject, I hope to be excused expressing more at large (though still in a very summary, and imperfect manner), my sense of it, and in giving a cursory glance, at the *final cause* of a contrivance, by which we live.

RESEARCHES carried far into nature, constantly lead us to traces of an All-governing DEITY, exercising a sovereign authority over HIS works. The motions of the largest masses, and most minute

nute particles of matter, all performed SECT.  
with the same order and ease, and re- VI.  
gulated by laws surprisingly simple and  
extensive, penetrating the inmost recesses of bodies, and extended throughout the *universe*, evince the direction of an omnipresent almighty Power actuating the whole.

IN every part and operation of nature, the fitness of things to one another, and *one design*, and their subserviency to the best ends, and to the use and felicity of intelligent Beings, point out the consummate wisdom and goodness of *One great Artificer, One original Mind.*

THE *course of Nature* is undoubtedly the effect of the incessant direction of the DEITY, no less than its creation and original arrangement: it seems impossible, and incomprehensible, that

SECT. any mechanical power, any organization of mere matter, could of itself, without direction or art, produce vegetables and animals, all machines of exquisite construction, at all times and every where arising into being in amazing profusion : tasting life, and by an established order, made instinctive and blind instruments to bestow it on others, and then retiring from this stage of existence after a short appearance upon it. But,

— — — “ *The universal Cause  
Acts not by partial, but by general Laws.* ”

By such laws originally established to secure the uniformity of nature, the constancy of cause and effect, and the permanency of species ; GOD directs the successive evolutions of the animal and vegetable tribes. The verdure of the field, and all its flowery plants, the humble shrubs, and the

lofty trees, in infinite variety, are his SECT. constant care, as well as his bounteous gift. Sole giver of life HE inspirits with animation, the meanest insect, and most abject reptile, no less than the more perfect and nobler animals, and by HIS wisdom guides them all to the several ends of their existence (n).

### EVERY

(n) This is a truth deduced from the most profound examinations into nature, as well as, apparent from a superficial survey of it, and agreeable to *common sense*.

'Tis a truth proved and confirmed by the discoveries of a HALLER and a BONNET, as well as by the researches of the ablest interpreters of nature in all former times. By those of ARISTOTLE, CICERO, GALEN, BACON, BOYLE, NEWTON, MC. LAURIN, who concur in demonstrating that the last *Link* in the *Chain* of natural causes terminates at the throne of GOD.

In vain have various persons endeavoured to give a satisfactory account of the origin of organized Bodies by any mere mechanical operation: as easily might we conceive a Watch capable of producing its like without a Maker. The efforts of a modern writer of great genius in favour of this cause, have not given more satisfaction than those of DEMOCRATES and DES CARTES formerly gave. Happy in overturning the *false* system of generation founded on the observations of LEEWENHOECK, he has built upon its ruins one, no less imaginary, and in all respects more exceptionable.

The Microscope, indeed, discovers to us, not only in the *seminal liquors* of animals of *both sexes*, but also in infusions of all kinds

## ESSAY ON THE USE OF

SECT. EVERY thing, in fine, on Earth and  
 VI. in the Heavens, manifests and presents  
 —— HIM to us ; and in the wonders of  
 the

kinds of animal and vegetable matter, *Animalcules* small and various beyond all conception, but still possessing every characteristic of a living and complete animal.

Though these Animalcules are over-rated in the LEEWEN-HOECKIAN system of Generation ; they are under-valued in that of DE BUFFON, and have, like ignes fatui, led both into mistakes.

To call these microscopic Animals, particles of mere *unorganized matter, self-moved, and self-active—organic particles, unorganized, but tending into organization, & une matière vivante*, is a prodigious petitio principii, and abuse of language.

But still, in order to evade the acknowledgement of art in the formation of animals, it is said, These organic particles are determined to this or that shape, are organized, by means of animal *Moulds*: this is still assuming what is destitute of proof, and saying what cannot be conceived or understood, if any thing else is thereby meant besides the assimilating power of a body already formed. In any other sense, moulds capable of forming machines so complete, so astonishing, of imparting form, external and internal, order, connexion, motion, life, with such amazing exactness and propriety, in machines consisting of such a prodigious variety of parts, would be more wonderful than the machines themselves : they explain nothing, and instead of showing how animals may be made without art, they suppose a higher exertion of it ; but an exertion passing all comprehension : and this celebrated modern system, with all the embellishments of eloquence, and ornaments of language, has not the credibility even of a Romance.

The *vital* and essential parts of animals could not have subsisted separately, or been produced one after another, but must have

the lowest, as well as the most magni- SECT.  
ficent of HIS works, the understand- VI.  
ing with transport traces the perfections     
of

have been one coœval system, formed at once, and connected together previous to what is called *Generation*, which is in fact only the occasion of the growth and increase of these Rudiments of a nervous and vascular system in bulk and strength, and into such parts, as are capable of shooting and vegetating from them.

If it be admitted as essential to animal life, that the heart should receive its nervous influence from the brain, and the brain its nourishing blood, and the liquor it is to separate for the use of the nerves and the purposes of muscular motion and sensation, from the arteries; and, that a part of these fluids should again return to the heart by the veins: it is easy to perceive that in the generation of animals, a heart and a brain, and their communicating vessels, and mutual dependencies, could never be produced at all, much less produced at once, by the circulation of the different liquors of the parent animal in their proper vessels, or by any alteration these liquors undergo in the *organs of secretion or of generation*: and that the production of an animal, is a work not to be effected by matter and motion alone, and is superior to all mere mechanical means.

Good observations and just reasonings lead us to conclude, that all plants and all animals whatsoever, in their seminal state, are preformed, and that their essential parts exist in miniature; but in a dormant and inactive state, very different from that of *microscopic animalculæ*, or moving *particles* seen by the aid of *Microscopes*.

Fecundation puts this germinating principle, this *bud of Being*, peculiar to every species, into life and action. The male sperm stimulates the little heart, and rouses it into motion, and gives occasion to a circulation of liquors in organs prepared for it,  
but

SECT. of a CREATOR, who is not far from  
 VI. every one of us, and in whom we  
 live, move and have our being; sees His  
 fingers touching the keys of nature,  
 producing harmony in the universe;  
 and His omnipotent arm unwearied  
 for

but till then at rest ; it is thus the means of nourishing, enlarging and unfolding what already existed, what was already formed and created, but creates nothing. Creation is the work of God alone. As HE is *our* true Father, and all plants and animals which are, have been, or shall be upon the earth, are indeed the immediate productions of His hand.

If it be found impossible to account for the re-production of animals by equivocal generation, or by any mere mechanical operation ; and, in order to obtain some tolerable comprehension of this great mysterious work, we must have recourse to superintending intelligence, and refer the generation as well as formation of animals to the art and power of God ; I see no reason why, to the exclusion of the same active principle, we should very anxiously seek to refer the involuntary and vital motions of animals to mechanical causes alone, or to any other than to their original mover ; especially when we consider that these motions seem designedly withheld from the volitions of our own minds, and that, unconscious of them, we neither deliberate concerning them, nor even find them obedient to the authority of our Will.

The many unsuccessful attempts of ingenious Physicians to account for these motions on the principles of mere mechanism, should convince us of the vanity of such attempts, and that they labour under some insuperable difficulty. Nor can the doctrine of STAHL, who refers all these motions to our soul, be admitted

for so many ages sustaining, conduct- SECT.  
ing every thing. VI.

BUT we ourselves are an abridgment of the universe, and, with reverence be it spoke, contain within us the image of its CREATOR; and were it possible not to trace HIM in that vast Theatre where HE exercises His power and wisdom with such magnificence, we might nevertheless contemplate HIS Being and Attributes displayed in our structure, and exercised in our preservation.

M

THE

ted, 'till, the adherents to his sect inform us, when the soul first began to be cloathed with body, and assumed the direction of its economy, and operations, of which, after all our researches, we remain so ignorant: when it first ventured to let the heart pant, and imparted motion to the vital parts; and when it exercised the power of suspending and renewing these motions: 'till, I say, we are better satisfied in all these particulars, it will be most rational as well as decent, to refer the carrying on, and direction of, the vital and involuntary motions of animals, with their formation, to the DEITY by whom, indeed, we are fearfully and wonderfully made and preserved.

SECT. VI. THE mechanism of our body, the connexion and subserviency of all its parts to a common purpose, the exquisite contrivance of its organs, consisting of all the various orders of vessels, interwoven with wonderful art, have led Anatomists in all ages to acknowledge an infinitely wise and powerful Maker. Among the most precious remains of antiquity, are those commentaries of GALEN, wrote on the uses of the parts of the human Body, as hymns and offerings of praise to the great CREATOR of it. Is it, indeed, otherwise conceivable how such consistency and harmony could have taken place in the different parts of our wonderful frame? How they could have been so exactly fitted to each other, and to the exterior objects, which have an evident relation to them, and the system they compose? Could the bones and muscles have been so well disposed for motion,

motion, without a superior knowledge SECT.  
in mechanics? The Eye so admirably VI.  
adapted to admit light and appropriated  
to vision, was it formed without a  
knowledge of optics? Or the Ear, with-  
out the science of sounds? To attri-  
bute contrivances like these, and even  
Understanding itself, to unintelligent  
causes, rather than to the all-wise Pa-  
rent of Nature, seems an incomprehen-  
sible perversion of Reason and Philo-  
sophy.

FROM the curious structure of our bodies we infer the wisdom and power of our Maker; but in the constitution and operations of our rational Souls, Man's noblest part, and true essence, the image of GOD is impressed and delineated, and His government of the universe exemplified, more especially in the conscious exercise of that power, by which, we, as free agents, are ca-

SECT. VI. pable of exciting an infinite variety of movements in our bodies, all of them depending upon, and regulated by our volitions ; while others go on with a seeming spontaneity and independance, and begin and end only with life itself.

EVEN our inclinations and passions, those sources of so much apparent ill, are, by the DEITY, providently rendered the means of our preservation both as individuals and as a race : and an instinctive affection for these ends and those means, powerfully operate upon us, and like two different powers acting in one direction, conduct us with redoubled force to the ends intended by our Maker to be produced by them. These important ends are always less secured by our instinctive love of life, fear of death, and natural desire of progeny, than by the more vehement appetites and instincts, which allure us to

to the exercise of certain faculties more SECT. immediately as gratifications, than as the VI. efficient means, which by experience ~~were~~ are known to fulfill the purposes of nature: and these instincts have in common with every spring of action infixed in our frame, a strength and impetuosity capable of carrying us too far, the more certainly to secure their efficacy as incitements to the great ends of animal life.

YET, the love of life and all its enjoyments, and the fear of death and all its dreaded harbingers, would have been but insufficient securities for our carrying on the vital motions, with that constancy and uniformity necessary to the preservation of life, if these motions had depended on our will and choice. Reason would have deliberated concerning them with too much slowness, and volition would have executed them with

SECT. with a dangerous and fatal caprice.

VI. For, if the heart had been subjected to  
the Soul's authority as much as the voluntary muscles are; if its motions could have been suspended, or stopt with the same facility, Death would then have cost us no painful pang: and, whenever the body was tortured by pain and disease, or the mind in anguish from grief or disappointment, a remedy so easy to be applied, (an escape from all *present* misery made by the very act, and in the instant, of choice) would have been recurred to with a dreadful frequency. Death, no longer armed with pain and terror, would in a short time have extirpated the human race.

THE preservation therefore, and security of life in every moment of it, depends upon our vital motions being entirely subject to the wise government of the Author of our lives; who charges

HIM-

HIMSELF, with the immediate care, of SECT.  
them, and, of us.

VI.



ALL this, when attentively considered, must affect us with a sense of GOD's goodness; *who*, tenderly respecting the imbecility of man's nature, hath been pleased by appetites and passions, to excite him to acts of self-preservation; and where the violence of these might have been hurtful, no less than the flowness and instability of Reason, hath taken our safety under his own more immediate direction.

THAT mind must be strangely possessed and bewildered with false science, which rather seeks for the cause of these involuntary motions in dead matter, organization, chance, necessity, something that without knowledge or power, acts wisely and powerfully, than in the great fountain of *Power, Wisdom* and *Animation*. UN-

SECT. UNLESS to such, this field of study,  
VI. (to use the words of an elegant writer), (o) " cannot be barren of Praise  
" to our CREATOR, nor unproductive  
" to ourselves of that noble and un-  
" common union of science and ad-  
" miration, which a contemplation of  
" the works of infinite wisdom alone  
" can afford to a rational mind ; whilst  
" referring to HIM whatever we find  
" of right, or good, or fair in ourselves,  
" discovering His strength in our weak-  
" ness and imperfection, honouring  
" them where we clearly discover them,  
" and adoring their profundity where  
" we are lost in our search, we may be  
" inquisitive without impertinence, and  
" elevated without pride ; we may be  
" admitted (if I may dare to say so)  
" into the counsels of the Almighty by  
" a consideration of HIS WORKS."

(o) Essay on the sublime and beautiful.

T H E E N D.









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